

Conference Paper

History of Studying Semantic Aphasia Mechanisms (Based on Materials from Lurian Archive)

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Abstract

The scientific heritage of Alexander Luria is vast and not completely studied. His scientific archive includes a range of documents that academics have never encountered. We analyzed the history of Luria's research of semantic aphasia, specifically as it is related to the impairment of visuospatial processing. For this purpose, we investigated unpublished archive materials dating back to 1928–1940, particularly the monograph 'Parietal Aphasia' from 1940. The literature regarding the history of the issue and neurophysiological and linguistic interpretations of semantic aphasia is discussed in detail by Luria. We also introduce Luria's diagnostic manual for the semantic impairment of language and describe the syndrome structure of semantic aphasia. To conclude, we discuss the specificity of semantic aphasia analysis in the pre-war monograph compared to later studies.

Keywords: semantic aphasia, visuospatial processing, temporal-parietal-occipital association area, A.R. Luria, neuropsychology, neurolinguistics, history of psychology

1. Introduction

A significant part of Alexander Luria's scientific archive is stored at the Laboratory of Neuropsychology within the Faculty of Psychology at Lomonosov Moscow State University. Evgeniya Khomskaya, an academic follower of Luria, first kept these materials; after her death they were bestowed to the laboratory. The faculty archive contains more than 10,000 pages of material, dating from the 1920s to the 1970s, thus incorporating nearly the entire research activity of the famous scientist. The archive documents allow for a reconstruction of Luria's investigations in very different fields of study. We are going to focus only on his investigations of **semantic aphasia**.

Semantic aphasia was described in all the classical works by Luria, including 'Traumatic Aphasia' [1], 'Higher Cortical Functions...' [2], 'The Working Brain' [3], and 'Basic

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Problems of Neurolinguistics' [4]. This type of language impairment refers to a deficit of spatial and quasi-spatial analysis and synthesis, and appears in the case of injury to the inferior parietal (parietal-occipital, temporal-parietal-occipital, or TPO) regions of the brain's left hemisphere. It manifests in poor understanding of reversible logical-grammatical structures. These utterances require an understanding not only of the isolated words included within them, but also the practical visual context in which the utterances emerge. For effective understanding of such structures, one needs to grasp the relationship between the words in such structure, based on spatial representations. Examples of such utterances include the structures 'the barrel under the box' or 'the brother's father', which are broadly used by neuropsychologists in diagnostic tests of semantic aphasia. A wide audience became familiarized with this impairment through the book 'The man with a shattered world: The history of a brain wound', devoted to the case-study of a patient named Zasetzky who suffered from semantic aphasia [5]. We will hereafter try to trace the history of the study of semantic aphasia, relying on the aforementioned archive materials and comparing them to the classical works of the famous scientist, including the latest ones.

Let us turn to the archive materials. They contain a folder named 'Elementary semic (semantic) operations', the term coined by Lev Vygotsky, in close cooperation with whom Luria conducted his clinical work [6]. This folder includes 106 pages of **protocols from 1928 to 1936** with 15 patients' diagnostics results. These protocols reflect Luria's significant interest in the patients' difficulties in understanding logical-grammatical structures, one of the two main symptoms of semantic aphasia. According to the protocols, patients were presented with grammatical structures of varying complexity: comparative structures ('Which square is darker/lighter?'), structures with genitive ('a mother of a daughter') and instrumental ('Show the pencil with the key') cases, as well as structures with spatial meanings (under/above, on the left/on the right; e.g., 'Put the pencil to the left of the book'). All of these tasks were included in the classical test battery for speech comprehension diagnostics. Along with that, patients underwent a neuropsychological assessment of speech production, thinking, and spatial functions. The latter were assessed through a variety of tests, namely Henry Head's Hand-Eye-Ear test and tasks on drawing and visuoconstruction.

A large body of material concerning speech comprehension research can be found in the other folders, particularly in the huge (more than 500 pages) set of protocols of the neuropsychological assessment of the patient Avt. who suffered from cerebral syphilis. Luria assessed him from 1929 to 1934. Avt. demonstrated inactivity, which increased as time went on, significant impairments of language and thinking, as well

as poor insight and situational orientation. Luria was especially concerned with Avt.'s understanding of logical-grammatical structures and verbal reasoning. The latter was tested using tasks requiring explanations of syllogisms, looking for mistakes in the patient's judgements and so on. The same tasks were given repeatedly, with elements of a teaching experiment.

What conclusions did Luria draw from the aforementioned work? **The monograph 'Parietal (Semantic) Aphasia'** [7], written in 1940 and stored in the archive, has never been published. This is part of an unfinished three-volume collection of studies. The first volume, 'Sensory aphasia', was finished and presented as a text of the successfully defended thesis on neurology. The third volume was devoted to the analysis of motor aphasia. The manuscript of the second volume, being of particular interest to us, is unfinished; it consists of 171 pages, while the typescript includes 219 pages.

Let us briefly discuss each chapter of this work. In the first part (pp. 3–77), Luria reviews **the history of the issue** in detail, including neurologists' conceptualizations of the semantic aspects of language impairment. The author distinguishes two main approaches in the preceding and contemporary literature, namely associationism (Broca, Brodbent, and Lichtheim) and anti-localizationism (Goldstein and Gelb). *Associationists* explained the semantic disturbance of language by disrupted connections between a word and its representation, leading to 'verbal amnesia', or 'the loss of memory representations linked to a word'. Notably, the loss of representations was considered to cause an impairment of thinking but not of language. These authors argued for the presence of a center of representations or concepts (also known as the center of intellectual operations), which was localized in the TPO region. Such mechanistic ideas, in Luria's opinion, were fairly criticized by *anti-localizationist*, who significantly enriched the description of the disrupted connections between language and thinking in cases of injuries to the posterior brain regions. Thus, Goldstein and Gelb [8] described a patient with amnesic aphasia who had difficulties in color nomination. It was the change of the 'categorical attitude' toward reality that was the underlying mechanism of this impairment, according to their interpretation, rather than a poor retention of concepts in the memory. Instead of human categorical behavior, the patient demonstrated a more primitive, unmediated attitude to reality; his eye caught the differences between colors, but every color was not an instance of the particular category anymore. The capacity to classify colors was lost and replaced with concrete matching of the colors to one another by tint; therefore, the color names became senseless and were lost [7]. However, Luria also highlighted the drawbacks of this research. In his opinion, the analysis of thinking was carried out without respect to

the social-historical origins of human thinking, and categorical settings were derived 'directly from the work of the cerebral cortex' [7, p. 29]. In line with Luria, but in contrast with classics, Goldstein explained the pathology not through the loss of single static representations, but through the disturbed neurodynamic of the change between figure/background excitations. Nevertheless, it was Goldstein who attempted to directly derive the 'categorical behavior' from the brain's functioning, standing by parallelism similar to the associationists [7].

After discussion of the language semantics and changes of word meaning in aphasia, Luria analyzes the history of studying expressive and impulsive agrammatism and, finally, semantic aphasia. The contribution of Henry Head to the description of this impairment is important. It was Head who coined the term 'semantic aphasia' and showed that its central symptom was the impossibility of speech comprehension where its meaning went beyond the direct meaning of the words [9]. Patients had no trouble understanding distinct words or simple phrases, but could not 'catch' the meaning of the whole segment or sentence if it had a complex grammatical structure. Citing Head, Luria writes that these patients encountered problems when 'details must be synthesized to the meaningful whole' [9, p. 311]. Besides the impairment of language, the syndrome with poor detail synthesis to the whole included: praxis-gnosis deficits that could be revealed with Head's Hand-Eye-Ear test; spatial errors in drawings and visuoconstruction; and difficulties with calculations. This description is consistent with the viewpoint of other authors (Poetzl, Conrad, Zucker). According to Luria, the deficit in complex integration of spatial experience, as well as its connection to poor language semantics and the disruption of complex categorically organized systems, was finally considered to be the mechanism of semantic aphasia. Semantic aphasia was no longer described as a weakened form of sensory or acoustic-amnestic impairments.

To substantiate his own viewpoint on the mechanisms of semantic aphasia, Luria had to root his ideas in an interdisciplinary theoretical background. He thought it was necessary to analyze, on the one hand, the functioning of the brain regions linked to semantic aphasia, and on the other hand, the linguistic aspects of this type of aphasia. The literature review in the second part of the work [7, pp.78–124] is devoted to the hierarchical **cerebral organization of visual perception**. Whereas the primary visual cortex is involved in receiving elementary visual experience, the secondary visual areas participate in its structuring and summarizing, therefore supporting the perception of natural objects. Intact functioning of the tertiary TPO regions allows people to raise the perception of natural objects to the level of categorical perception through perceptual experience schematization and verbalization. The interaction

between different modalities makes possible the simultaneous synthesis of visual experience and mental representations, as well as spatial orientation and experience organization, and the semantic categorization of functional meanings developed in human social experience.

In the third part of the work [7, pp. 125–182] Luria turns to linguistics, conducting a detailed analysis of **the coevolution of language and thinking** during the human labor activity. In the earlier, ‘indicative’ stage, the pointing gesture was the instrument for visual space organization and the key feature extraction from it (later on, diffusive sound complexes played this role); it is considered the first means of social organization of perception [7]. In the next, ‘nominative’ stage of language development, distinct words began to nominate objects and actions. At that stage, language could designate some events but could not express complex ideas because language semantics did not yet go beyond substantial and indicatory word meanings [7]. ‘Sympractical context’ was essential for the understanding of distinct object and action designations. In the third, ‘logical-grammatical stage’, when instruments such as fixed word orders, particles, and inflections originated, language could not only designate different facts and actions but could also establish relations between them [7]. Language’s grammatical evolution and the development of language categories were changing language semantics. Now, a word included a complex system of abstract relations and connections. Following Vygotsky [10], Luria suggests that this changing of a word’s meaning turns the word into a concept, being the instrument of the verbal reasoning. Thus, the word becomes free from the situation, the visual space, and has the opportunity for ‘synsemantic’ motion. This part of the book ends with a conclusion that the TPO area is the most appropriate brain region for operating the meanings system because of its capacity to schematize visual experience. The syntagm was chosen as a unit of analysis of linguistic semantic destruction (on the analogy with the phonemic analysis deficit in acoustic-gnostic impairments).

The next chapter, ‘The method for the assessment of language semantics intactness’ [7, pp. 182–193], is devoted to the criticism of the era’s traditional tests. They were designed for studying speech comprehension through simple questions or instructions, an understanding of which was possible in context or in the case of efficient understanding of isolated words. Luria formulated three new **requirements for the diagnostics of semantic impairments of language**:

1. A conflict between the direct relation of the phrase to an object and the true meaning of the phrase. For example, the structure ‘the brother of the father’

means not the brother and not the father; one of the nouns must lose its relation to the object and become a symbolic attribute of another object or subject.

2. The possibility of assessing not only the semantic impairment, but also its degree. For this purpose, Luria suggests gradual simplifying the contemporary construction on the basis of the history of its emergence in language: for example, the father's brother is 'the brother of this father'.
3. Analysis of the particular way of performing the task. Luria means the hierarchy of these ways, from a rapid response with no assistance of the clinician, to an oral step-by-step solution, to an efficient solution with the help of the clinician, and finally to the possibility of repeating the instruction and impossibility to do even this.

In their generalized form, these requirements represent one of the first formulations of the methodological principles of neuropsychological diagnostics. These ideas are consistent with the principles of psychological diagnostics offered by Lev Vygotsky [11].

In the summary [7, pp. 193–197], Luria **draws conclusions** from his literature analysis and **plans the semantic aphasia description** for the next unwritten part of the work. He notes that semantic aphasia syndrome emerges in the case of injury to the TPO area, which belongs to the tertiary brain regions. Semantic aphasia is characterized by intact primary perceptual processes, but impaired 'experience schematizing' and 'integration of perceptual and intellectual processes'. In his opinion, language's capacity of organizing visual experience into the complex system of semantic coordinates can be explained by the idea that language contains all of the complex semantic connections and relations that have been 'conquered' by human society during activity [7]. A word in a developed language is a complex system of abstractions. A deficit in the TPO area's 'schematizing functioning' does not disrupt a word's meaning, its relation to a particular object. However, the word becomes isolated from the language's complex semantic system and loses its possibility of synsemantic motion in the semantic field.

The main semantic aphasia **symptoms** are distinguished by Luria in the summary. They are: (1) impairments of speech comprehension, namely logical-grammatical structure understanding and 'catching' the whole text's meaning; (2) a deficit of categorical thinking, with impaired 'inner field of discursive thinking'; and (3) the breakdown of knowledge structures caused by the impairment of relevant scientific concept systems. Since semantic aphasia is rooted in the most complex forms of

spatial experience organization, all of these symptoms appear in the background of (4) impaired simultaneous operating in spatial perception [7].

The work finishes with a few case-studies of patients with semantic aphasia. Luria intended to describe their clinical symptomatology in detail in the proceeding chapter, which, unfortunately, was not written.

It is well known that the hard work of Luria and his colleagues at the evacuation hospital in Kisegach in the Urals during the Great Patriotic War led to significant breakthroughs in neuropsychology and considerably changed Luria's viewpoints on some issues. In the book 'Essays on the Theory of Traumatic Aphasias', written in Kisegach [12], semantic aphasia was described in the same way as in the classical work 'Traumatic Aphasia' [1]. Let us compare **the specificity of semantic aphasia analysis in the work of 1940 and in the more recent works.**

Firstly, in the book of 1940 [7], Luria gives the most detailed rationale for distinguishing semantic aphasia syndrome, compared to his more recent works. Only in this book is the history of studying semantic aphasia described in detail. Luria also addresses the particular neurophysiological characteristics of the TPO area that allow this area to support visuospatial processing. The vast linguistic material discussed by Luria shows the language specificity of grammatical structures, the understanding of which is impaired in semantic aphasia. In [7], the discussion of this issue is nearly 170 pages long, whereas in the other works [1–3] it is only 1–2 pages or 1–2 paragraphs long. Only the 1940 text allows us to see the theoretical analysis that preceded Luria's semantic aphasia mechanism interpretation while it was in progress, step-by-step.

Secondly, Luria uses a slightly different terminology in this work. For example, he repeatedly emphasizes the 'schematizing' role of the TPO area. The understanding of the 'scheme' as an active process was introduced by Henry Head; after Frederic Bartlett it became popular in cognitive psychology. The frequency of this term in Luria's post-war studies significantly declines. Other terms gain popularity, such as 'simultaneous syntheses' (in the framework of discussion of the two information processing strategies, namely successive and simultaneous), 'visuospatial analysis and synthesis', and 'quasi-spatial' impairments (regarding the semantic deficit of language). Notably, Luria widely uses the terms 'visual field' and 'the field of personal meanings', also typical of the latter works by Vygotsky [13–16].

Along with that, in his more recent books Luria refuses the concept 'syntagm' as a unit of semantic organization in language (analogous with phoneme, being the basic unit of speech perception). The reason is that many syntagms (e.g., 'a piece of bread', 'the boy goes') do not require 'synsemantic' understanding. Therefore, the

concept 'syntagm' becomes too broad for describing the poor understanding of logical-grammatical structures, which are based on the 'communication of relations' principle by C. Svedelius [see in 4]. Such structures imply the simultaneous analysis of relations in the quasi-spatial field, in comparison to the structures based on 'communication of events'. In [4], Luria begins using the concept of 'reversibility', following Slobin [17], because all reversible structures (e.g., 'brother of the father', 'Peter was hit by Ivan') strongly require 'synsemantic' analysis [4]. Notably, although there was no term 'reversibility' in the work of 1940, reversible structures were distinguished and described as highly appropriate for language impairment diagnostics (as mentioned earlier).

Thirdly, in comparison to the books written in 1943, 1947, and 1969 [1, 2, 12], in the work of 1940 [7] Luria focused on verbal reasoning deficits and the breakdown of the meanings system. Commenting on the beginning of his studying aphasia, Luria wrote in the scientific autobiography that his and Vygotsky's initial understanding of brain functioning was greatly influenced by the ideas of the English neurologist Henry Head [6]. Head suggested that aphasia led to a decline in intelligence, because in this case thinking must rely on primitive, unmediated connections between objects and actions, instead of on language [9]. These ideas perfectly coincided with the distinction between the mediated and the natural processes in Vygotsky's approach. Therefore, Vygotsky and Luria, following Head, initially thought that language impairments caused people to react to stimuli in an unmediated, severely simplified way because of the impossibility of verbal mediation. These hypotheses would be later named 'naive' by Luria [6]. He would write: «We were greatly oversimplifying both the nature of aphasia and the intellectual processes in brain injured patients... These early pilot studies were encouraging, but they also showed us how much we needed to learn if we were to make the study of the dissolution of higher psychological functions an integral part of our effort» [6, pp. 128, 130]. In the works of [1, 2], based on the richest clinical material, he predominantly emphasized language impairments in the case of injuries to the TPO area. The difficulties in tasks aimed at thinking were considered to be secondary related to language impairments, and were linked to poor understanding of instructions and operating with logical-grammatical structures, whereas the level of generalization itself and thinking operations (analysis, comparison, etc.) were described as intact.

Fourthly, poor visual perception of natural objects was not included in the typical semantic aphasia syndrome in the works of [1, 2, 7], as distinct from the visuospatial

difficulties (on the levels of the body scheme, drawing, and visuoconstruction). However, in 'Basic Problems of Neurolinguistics' [4] Luria admits that poor visual perception is one of the mechanisms of nominative difficulties. He considered object nomination not to be just a simple association between a sound complex and a representation of the nominated object. According to Luria, object nomination included the extraction of the object's key feature with the distraction from all non-essential features [4]. Tsvetkova [18] demonstrated that patients with left temporal-occipital injuries often could not extract an object's key feature. Luria wrote that the aforementioned deficit made the perceptual basis of the nominated object imperfect and 'blurred', which could become a serious obstacle for finding the precise verbal name [4]. However, in the study by Tsvetkova, patients with acoustic-amnesic and semantic types of aphasia (predominantly of vascular etiology) were not divided. The later studies of semantic deficits, which distinguished both of these aphasic forms and slight visual agnosia [19–21], confirmed Luria's earlier viewpoint [1, 2]. Special experiments showed that patients with semantic aphasia, along with poor understanding of reversible grammatical constructions, experienced nominative problems because of the poor operating with a word's categorical meaning. However, they did not have primary auditory or visual gnostic deficits. In contrast, the patients with acoustic-amnesic aphasia demonstrated the fragility of the words' auditory representations (lexical items), their impaired referential meanings, and the poor connections between a word and its visual representation, which manifested in errors in the drawings of the nominated objects. Nevertheless, they successfully performed traditional tests on visual perception, similar to the patients with semantic aphasia and in contrast to the patients with visual agnosia. The latter experienced obvious problems with the drawing of nominated objects, poor perceptual classification, and the propensity to look for adequate object nominations in the oral speech. But intraverbal connections and connotative meanings were intact in them. In contrast to the patients with acoustic-amnesic aphasia, they were able to correctly classify animals that barked, meowed, purred, and roared into different groups [20, 21]. These experiments demonstrated the validity of the semantic aphasia mechanisms interpretation offered by Luria in 1940 [7]. Even on the basis of very poor clinical material (in comparison with later years), Luria managed to reveal the specific, not optic but visuospatial, factor underlying all semantic aphasia symptoms.

2. Conclusions

Acquaintance with Luria's early works on semantic aphasia allows us to better understand the background that shaped his viewpoint on this topic. Three detailed literature reviews, presented in his 1940 book, from neurology to linguistics, were Luria's basis for his ideas on the brain, the coevolution of language and thinking, as well as his viewpoint on the mechanisms of higher mental function impairments in the case of injury to the TPO area and semantic aphasia syndrome. The diagnostic techniques developed on this basis have become the gold standard of neuropsychology. As early as the pre-war period (before 1941), Luria managed to describe the most essential components of semantic aphasia syndrome and to relate them to a primary deficit. Acquaintance with the pre-war period of the great scientist's work is important not only for understanding the history of studying one or another syndrome, but for the analysis of the whole period of neuropsychology development. Lurian neuropsychology as a science is traditionally considered to be completely shaped for the first time in 1947 in 'Traumatic Aphasia' [1]. However, its main characteristics, such as being a systemic interdisciplinary approach, as well as the evolutionary, social-historical approach to mental processes analysis and their brain mechanisms, can be found even in the materials of 1928–1940.

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